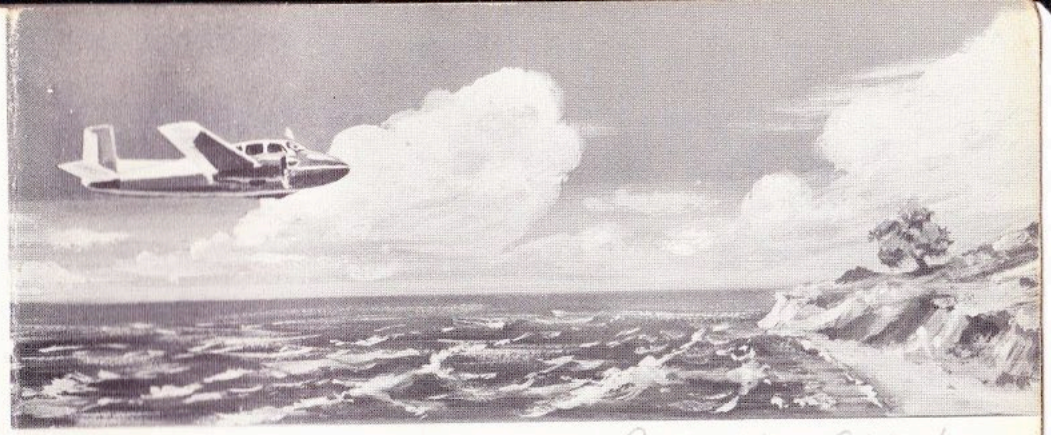
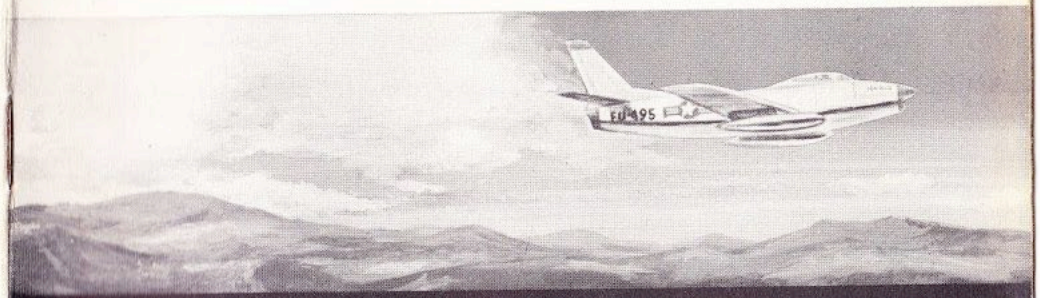


James Cord
810 Minot Ave.
Auburn Me.

AIRCRAFT IN FLIGHT



WORK BOOK

d. A fixed pitch propeller is not an efficient as one on which the pitch is adjustable.

e. As altitude increases, air becomes less dense.

f. One of the two primary airfoils in an airplane is the wing. The other is the propellers.

g. The safest gas for lifting lighter-than-air craft is helium because it will not burn.

h. Heavier-than-air craft include Gliders, Helicopter and airplanes.

i. Lighter-than-air craft include balloons, blimps and dirigibles.

j. Gliders are also known as Glaeplanes.

EXERCISE NO. 3

(You have 5 minutes to complete this exercise.)

1. Draw a circle around the number preceding the phrase which is best to make the statement a correct expression.

a. Propellers and wings are:
   1. Usually made of wood.
   2. The primary airfoils in an airplane.
   3. Set at the same pitch.
   4. Subjected to the same stresses.

b. Helium is more satisfactory in lighter-than-air craft because:
   1. It is cheaper.
   2. It has greater lifting power.
   3. It is non-burnable.
   4. It will not leak out.

c. Lighter-than-air craft include:
   1. Balloons, dirigibles and gliders.
   2. Airplanes, helicopters and gliders.
   3. Gliders, helicopters and balloons.
   4. Blimps, balloons and dirigibles.

d. The first aircraft to carry man aloft was:
   1. A blimp.
   2. A glider.
   3. A balloon.
   4. A helicopter.

e. Airplanes, helicopters and gliders all have a principal structure called:
   1. Rotors.
   2. An envelope.
   3. A fuselage.
   4. Nose wheels.

EXERCISE NO. 4

(You have 15 minutes to complete this exercise.)

1. Draw and label a figure representing a balloon, a blimp and a dirigible.

2. Draw, label and then list the major components of a glider, airplane and helicopter.

3. Write a brief essay of at least fifty words describing what, in your opinion, are the basic differences between lighter-than-air and heavier-than-air craft.

Lesson VIII

EXERCISE NO. 1

(You have 5 minutes to complete this exercise.)

1. Place a *T* in the blank space which precedes a true statement; place an *F* in the blank space which precedes a false statement.

a. F An airplane gets all of its lift from the engine power transmitted through the propeller.

b. T The faster an airfoil travels through the air the greater is the lift on the wings.

c. F Newton's law of action and reaction does not apply in a vacuum.

d. T Part of the lift force applied to a wing in flight is caused by the downward deflection of air on the bottom of the wing.

e. F The pressure of air is constant regardless of altitude above sea level.

f. F The most effective airfoil is one where the top and bottom sides have the same curvature.

X T g. Air is a fluid.

h. T The movement of an airfoil through the air creates a relative wind.

i. F The direction of the relative wind is never parallel to the line of flight.

j. F Although it exerts pressure, air has no weight.

EXERCISE NO. 2

(You have 10 minutes to complete this exercise.)

1. Fill in blank spaces with the word, or words, that properly complete the statement.

a. For every action there must be an equal and opposite ..... reaction .....

b. As the velocity of air increases, its pressure ..... decreases .....

c. As the velocity of air decreases, its pressure ..... increases .....

d. Air has three characteristics. It is ..... gas ..... It exerts ..... weight ..... and it has ..... pressure .....

e. When we speak of mass per unit volume, we are speaking of ..... Density .....

f. The recoil of a gun is an example of a ..... nozzle X

g. A tube, wide at each end but narrow at the throat between the openings, is a ..... venturi tube .....

h. Air moves across the top and under the bottom of a wing. The air moving across the top moves ..... fast .....

i. At sea level air exerts a pressure of about ..... 15 lbs per in .....

j. The movement of the relative wind over the top of the wing contributes to the force called ..... lift .....

EXERCISE NO. 3

(You have 5 minutes to complete this exercise.)

1. Draw a circle around the number preceding the phrase which is best to make the statement a correct expression.

a. Density is defined as:
   1. Thickness.
   2. Mass times weight.
   (3.) Mass per unit volume.
   4. Compressibility.

b. Air is:
   X (1.) A gas.
   (2.) A fluid.
   3. A solid.
   4. Is made up of electrons and neutrons.

c. The direction of the relative wind is always:
   1. Perpendicular to the line of flight.
   2. At right angles to the angle of incidence.
   3. Opposite to lift
   (4.) Parallel to the line of flight.

d. When altitude is increased above sea level:
   1. Pressure increases and weight decreases.
   2. Weight increases and pressure decreases.
   (3.) Pressure and weight decrease.
   4. Pressure and weight remain constant.

e. Forces acting on air can cause it to be:
   X (1.) Compressed or expanded.
   (2.) Heated and therefore compressed.
   3. Cooled and therefore expanded.
   4. Transferred into a liquid form.

EXERCISE NO. 4

(You have 15 minutes to complete this exercise.)

1. Draw a cross section of an airfoil.

2. Show the effect of relative wind on an airfoil. (Use the illustration in 1 above.)

3. State in your own words Newton's law of action and reaction and Bernoulli's principle of pressure-differential. Cite an example of both principles in practice.

Lesson IX

EXERCISE NO. 1

(You have 5 minutes to complete this exercise.)

1. Place a *T* in the blank space which precedes a true statement; place an *F* in the blank space which precedes a false statement.

X a. F An airplane will balance at the center of pressure.

b. T Pilots have some control over induced drag.

c. F Drag is the result of the force of weight.

X d. T Take-off runs are normally shorter at sea level than at 10,000 feet.

e. F The chord line runs laterally from wing tip to wing tip.

f. T Aspect ratio is the quotient of span divided by average chord.

g. F Parasite drag and induced drag are caused by skin friction.

h. T Form drag is least on teardrop shaped objects.

i. T Thrust and drag are equal when an airplane is in straight and level flight.

j. F Airspeed and groundspeed are the same provided temperature is constant at 59 degrees Fahrenheit.

EXERCISE NO. 2

(You have 10 minutes to complete this exercise.)

1. Fill in the blank spaces with the word, or words, that properly complete the statement.

a. The four forces acting on an airplane in flight are lift, weight, thrust and drag.

b. Lift acts in opposition to weight.

c. thrust acts in opposition to drag.

d. Angle of attack is the angle formed by the chord line and the relative wind.

e. Water vapor weighs about five eights as much as an equal volume of dry air.

f. A wing having a span of 40 feet and a chord of 5 feet has an aspect ratio of eight.

g. Another name for form drag is eddy drag.

h. Lift is related to wing dimensions, to air speed, to angle of attack and to air demands.

i. Vortices result from the spilling of air into the low pressure area above the wings.

j. Density of air is more at sea level than at higher altitudes.

EXERCISE NO. 3

(You have 5 minutes to complete this exercise.)

1. Draw a circle around the number preceding the phrase which is best to make the statement a correct expression.

a. Two of the four forces acting on an airplane in flight which act in opposition are:
   1. Lift and thrust.
   2. Drag and weight.
   3. Thrust and drag.
   4. Gravity and drag.

b. Angle of incidence is:
   1. Parallel to the relative wind.
   2. Never fixed.
   3. The angle between the chord line at the wing root and the longitudinal axis of the airplane.
   4. The angle between the chord line at the wing root and the relative wind.

c. Induced drag:
   1. Has no relation to the angle of attack.
   2. Has an indirect relation to the angle of attack.
   3. Has a direct relation to the angle of attack.
   4. Has a direct relation to aspect ratio.

d. Induced drag is:
   1. Avoidable to a degree.
   2. The unavoidable result of lift.
   3. Always greater than form drag.
   4. Reduced as parasite drag is increased.

e. One of the four forces over which pilots and designers have no control is:
   1. Thrust.
   2. Drag.
   3. Lift.
   4. Weight.

EXERCISE NO. 4

(You have 15 minutes to complete this exercise.)

1. Make a cross section drawing of an airfoil showing relative wind, angle of attack and angle of incidence.

2. Draw a streamlined body and show its effect on the relative wind.

3. Define three types of drag and cite an example of how each occurs.

Lesson X

EXERCISE NO. 1

(You have 5 minutes to complete this exercise.)

1. Place a *T* in the blank space which precedes a true statement; place an *F* in the blank space which precedes a false statement.

a. T There are three axes around which an airplane moves.

b. F Drag is the term applied to movement around the lateral axis. pitch

c. T Load limit is the ratio of a load to the design weight of an airplane. factor

d. F To turn left a pilot moves the control stick to the right.

e. T Roll is movement about the longitudinal axis.

f. F Stalls occur only at minimum speed.

g. F Dihedral and sweepback mean one and the same thing.

h. F Thrust, drag, tension, shear and bending are the five stresses imposed on an airplane in flight.

i. T Normally, the maximum angle of attack is 20 degrees.

j. T Any change in attitude of an airplane involves movement about at least one axis.

EXERCISE NO. 2

(You have 10 minutes to complete this exercise.)

1. Fill in the blank spaces with the word, or words, that properly complete the statement.

a. The pilot controls movement about the three axes by means of throttle, stick and rudder.

b. Yaw is movement about the vertical axis, Pitch is movement about the lateral axis and Roll is movement about the Longitudinal axis.

c. sweepback and dihedral provide stability about the vertical and longitudinal axes.

d. Tension forces tend to pull a structure apart.

e. There is a direct relation between load and design weight. This relation is called load factor.

f. Movement of the throttle fore or aft will cause an airplane to climb or dive.

g. The acceleration produced by gravity is 32.17 feet per second per second.

h. A 150-lb. pilot under a 2 G force load weighs 300 pounds.

i. Structural failure can result from high speed flight through thin air.

j. Maneuvering speed is 70 percent greater than normal stalling speed.

EXERCISE NO. 3

(You have 5 minutes to complete this exercise.)

1. Draw a circle around the number preceding the phrase which is best to make the statement a correct expression.

a. Stalls and spins are:
   1. Dangerous.
   2. Not permitted.
   3. Normal reaction to control movement by the pilot.
   4. Always to be avoided.

b. Dihedral provides:
   1. Stability about the vertical axis.
   2. Stability about the longitudinal axis.
   3. Stability about the lateral axis.
   4. Stability at the center of pressure.

c. Elevators control movement about:
   1. The lateral axis.
   2. The vertical axis.
   3. The longitudinal axis.
   4. The horizon.

d. The five stresses acting on an airplane in flight are:
   1. Tension, bending, torsion, compression and thrust.
   2. Lift, weight, thrust, gravity and drag.
   3. Tension, compression, bending, shear and torsion.
   4. Load factors which affect the balance of an airplane in flight.

e. Holding top rudder causes a:
   1. Spin.
   2. Stall.
   3. Slip.
   4. Skid.

EXERCISE NO. 4

(You have 15 minutes to complete this exercise.)

1. Name and then cite an example of each of the five stresses imposed on an airplane in flight.

2. Explain in your own words the comparison between the structural design of a bridge and an airplane.

3. Write a statement why load placement affects the flying characteristics of an airplane.

Lesson XI

EXERCISE NO. 1

(You have 5 minutes to complete this exercise.)

1. Place a *T* in the blank space which precedes a true statement; place an *F* in the blank space which precedes a false statement.

a. F Transonic speed includes all speeds less than the speed of sound.

b. F The Mach number of an airplane is its air speed in miles per hour divided by the speed of sound.

c. T A shock wave is a piling up of air in front of an object moving faster than the speed of sound.

d. T Reducing the thickness of an aircraft wing reduces the speed of the relative air flow over the wing.

e. T Shock waves can form when an airplane is flying at subsonic speed.

f. T Supersonic speeds are designated by a Mach number.

g. T In supersonic flight, a shock wave tends to follow the original line of flight of an airplane after it has changed course.

h. F Supersonic boom is the term applied to the needle-shaped object protruding from the nose of high speed fighters.

i. T Airplanes designed in accordance with the Area Rule have fuselages pinched at the waist.

j. T Sweepback delays the formation of shock waves in both subsonic and supersonic flight.

EXERCISE NO. 2

(You have 10 minutes to complete this exercise.)

1. Fill in the blank spaces with the word, or words, that properly complete the statement.

a. Supersonic speeds are designated by a mach number instead of by miles per hour.

b. Mach number is obtained by dividing air speed in feet per sec. by the speed of sound.

c. An airplane flying at four times the speed of sound has a Mach number of 4G.

d. Under standard conditions the speed of sound at sea level is 760 mph.

e. The sonic barrier is reached when the speed of an airplane reached the speed of sound.

f. Attached to the trailing edge of the vertical stabilizer is the rudder.

g. There are two principal types of wing construction. They are aerobatic and utility.

h. Speeds greater than the speed of sound are termed supersonic.

i. The Reynolds number of an airfoil changes as the speed, altitude and weight of air changes.

j. rudder, aileron, flap and elevators are auxiliary flight control members.

EXERCISE NO. 3

(You have 5 minutes to complete this exercise.)

1. Draw a circle around the number preceding the phrase which is best to make the statement a correct expression.

a. A type of military airplane which is quite similar to a civilian type is:

1. A bomber.
2. A transport.
3. A fighter.
4. A jet trainer.

b. Airplanes are classified on the basis of:
1. Exterior, interior, installed equipment and landing gear.
2. Pusher, tractor, in-line or radial.
3. Purpose, engine, wing and landing gear.
4. Clipped wing, sweptback wing, delta wing or straight wing.

c. The two basic types of fuselage construction are:
1. Semi-cantilever and cantilever.
2. Longerons and stringers.
3. Truss and monocoque.
4. Monocoque and semi-monocoque.

d. The principal structural parts of a wing are:
1. Fabric, metal and spars.
2. Spars, ribs and cap strips.
3. Stiffeners, stringers and ribs.
4. Spars, ribs and stringers.

e. A type of landing flap which can be recessed into an airfoil is called:
1. A spoiler.
2. A Fowler flap.
3. A split flap.
4. A cowl flap.

EXERCISE NO. 4

(You have 15 minutes to complete this exercise.)

1. Draw a top view of an airplane which will be least affected by shock waves as it passes through the transonic zone.

2. Draw a top view of an uncovered wing structure and name as many structural parts of the wing as you can.

3. List the flight controls which make up the main and auxiliary groups.

Lesson XII

EXERCISE NO. 1

(You have 5 minutes to complete this exercise.)

1. Place a *T* in the blank space which precedes a true statement; place an *F* in the blank space which precedes a false statement.

a. T Instruments are classified into four major groups.

b. F Pressure in a hydraulic system diminishes in direct proportion to distance.

c. T Operation of a hydramatic propeller employs the principle of hydraulics.

d. F Bernoulli discovered the principle of hydraulics.

e. T The application of the hydraulic principle makes it possible to increase a force originally exerted.

f. T A manifold pressure gauge is an engine instrument.

g. F A bourbon tube reacts to pressure.

h. F A diaphragm reacts to spring tension and temperature.

i. T Solenoids are used to operate large switches and valves.

j. F A drift meter is considered to be a pressure instrument.

EXERCISE NO. 2

(You have 10 minutes to complete this exercise.)

1. Fill in the blank spaces with the word, or words, that properly complete the statement.

a. Bernoulli discovered the principle of hydraulics.

b. engine instruments, aircraft instruments, flight instruments and navigation instruments make up the four major groups of airplane instruments.

c. Resistance of a metal to the flow of electrical current changes directly as its temperature changes.

d. Pressure instruments employ either a bourdon tube or a temperature.

e. Another name for an altimeter is aneroid barometer.

f. engine instruments include the clock, compass, directional gyro and drift meter.

g. Voltage is the force that force an electrical current through a wire.

h. landgear, engine and wing are three airplane components which may be operated hydraulically.

i. One multi-engine airplane might employ well over 100 aircraft instruments.

j. It would be impossible to fly from point to point through clouds without Radio and compass instruments.

EXERCISE NO. 3

(You have 5 minutes to complete this exercise.)

1. Draw a circle around the number preceding the phrase which is best to make the statement a correct expression.

a. The physicist who discovered the principle of hydraulics was:
1. Newton.
2. Edison.
3. Bernoulli.
4. Pascal.

b. An example of a flight instrument is:
1. Compass.
2. Altimeter.
3. Oil pressure.
4. Air temperature.

c. Mechanism which converts change-in-resistance to change-in-current is:
1. A voltmeter.
2. A Wheatstone Bridge.
3. A bourbon tube.
4. A voltage regulator.

d. A magneto can also be classed as a:
1. Voltage amplifier.
2. Generator.
3. Conductor.
4. Solenoid.

e. Piston A is one square inch in area. Piston B is 20 square inches in area. When piston A exerts a 2-lb. force, the force exerted on piston B will be:
1. 40 lbs.
2. 100 lbs.
3. 80 lbs.
4. 20 lbs.

EXERCISE NO. 4

(You have 15 minutes to complete this exercise.)

1. State Pascal's principle of hydraulics.

2. Draw an instrument panel and list as many instruments as you can in each of the four major groups.

3. In fifty words describe the importance of hydraulic and electrical systems to modern day flying.

Lesson XIII

EXERCISE NO. 1

(You have 5 minutes to complete this exercise.)

1. Place a *T* in the blank space which precedes a true statement; place an *F* in the blank space which precedes a false statement.

a. T Fuselage structural stations are usually numbered from a zero point at the nose of the airplane.

b. F The center of pressure is the point at which the force of gravity is assumed to be concentrated.

c. F The ideal location for the center of pressure would be one-third back from the leading edge of a wing.

d. T A 10-lb. weight held 18 inches from the body would exert a downward force at the hand of 180 inch pounds.

e. T The fore and aft center of gravity limits for an aircraft are computed in inches from the reference point.

f. T Center of gravity and center of pressure must be relatively close to insure longitudinal balance.

g. T Elevators and other control surfaces are not marked with structural stations.

h. F In a 40-passenger airplane, it would make no difference if a total passenger load of 10 sat in the most rearward seats.

i. T In the formula "M equals AW", M is a product known as a moment; A is the length of the arm, and W is the weight of an object.

j. T Lift acts perpendicular to the center of gravity.

EXERCISE NO. 2

(You have 10 minutes to complete this exercise.)

1. Fill in the blank spaces with the word, or words, that properly complete the statement.

a. The weight of the contents of fuel tanks and baggage compartments affect the lateral and longitudinal stability of an airplane.

b. The fore and aft center of gravity limits must be known before an airline can be loaded properly.

c. The most forward center of pressure position is about 3/10 of the chord line aft of the leading edge of a wing.

d. It would be extremely difficult to assembly the many parts of an airplane properly without a system of station, numbering.

e. The center of pressure moves forward as the angle of attack increases.

f. In flight, when a person walks to the rear of an airplane, the center of gravity moves backward.

g. In flight, the center of gravity of an airplane changes as fuel is consumed.

h. There is a direct relationship between stability and weight and balance.

i. As the angle of attack decreases, the center of pressure moves rearward.

j. The pressure forces contributing is the point at which the force of gravity is assumed to be concentrated.

EXERCISE NO. 3

(You have 5 minutes to complete this exercise.)

1. Draw a circle around the number preceding the phrase which is best to make the statement a correct expression.

a. Two important airplane components which affect weight and balance and whose locations are indicated by station numbers are:

1. Landing gear and propellers.
2. Radio equipment and instruments.
3. Fuel tanks and baggage compartments.
4. Baggage compartments and control surfaces.

b. The center of pressure moves forward as the:

1. Center of gravity moves rearward.
2. Center of gravity moves forward.
3. Angle of attack increases.
4. Angle of attack decreases.

c. Chord is defined as the distance between the imaginary perpendiculars erected:

1. From wing tip to wing tip.
2. From the wing spars to the horizontal stabilizer spars.
3. At the leading and trailing edges of a wing.
4. At the center of gravity and the center of pressure.

d. Usually the distance from the center of gravity to the reference point is computed in:

1. Foot pounds.
2. Feet.
3. Pounds.
4. Inches.

e. The ideal location of the center of gravity would be:

1. Three-tenths rearward of the mean effective chord.
2. Four-tenths rearward of the mean effective chord.
3. One-third rearward of the leading edge of a wing.
4. Fifty percent of the mean effective chord.

EXERCISE NO. 4

At this point, if you have any question on the material covered in the previous seven classes, bring it to the attention of the instructor. This period will be devoted to answering any questions which you or the other students desire to have reviewed.